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in caves, old mines, wells, etc. I have specimens from the coal mines of Pennsylvania in which the growth is much larger than this. I suspect it is an effort on the part of the plant to get to the light, and instead of the usual sessile pileus it makes an elongated stem-like growth. It grows on wood; and it is possible, in some cases at least, that the wood may contain the mycelium when it is carried into the cave or mine."

This great difference of form, in the light of the suggestion of Dr. Peck, is one of the most interesting botanical facts of the cave. The specimens, when fresh, had, at the reddish tip, a white, powdery bloom that gave a bleached appearance to the last inch or more of the specimen. It was found growing in a damp station not far from the Bottomless Pit.

These main new facts in the occurrence and distribution of cave insects and plants have been presented as a contribution to a knowledge of the life of the most interesting cave on the continent. Its great expanse renders likely additional discoveries on complete study.

METHODS IN ECONOMIC ORNITHOLOGY, WITH SPECIAL REFERENCE TO THE CATBIRD.

By Sylvester D. Judd.

The determination of the food habits of birds is of vast importance in rural economy. Owing to the ignorance on this subject, such a grave mistake as the introduction of the English sparrow was made. In order to ascertain the food of any bird, and to determine its relation to agriculture, a definite scheme of investigation must be followed. Until recently the method employed was that of observing birds while feeding; but this gave such fragmentary knowledge that distorted conclusions were drawn, and many innocent birds suffered, particularly the hawks and owls, until Dr. A. K. Fisher,[1] by the careful examination of stomachs, showed that of the 49 species of our hawks and owls, only 6 are injurious to agriculture.

[1] Hawks and Owls of the United States, Bull. 3, U. S. Dept. Agriculture.

The method of field work, which requires the united efforts of a botanist as well as an entomologist, yields results which must not be considered a final solution to the problem, but only a contribution to our knowledge. Nevertheless, field work is indispensable, since many interesting facts may be learned by going to fruiting trees or shrubs and watching the birds that visit them. This sort of work can be done to a limited extent in a field where grasshoppers are abundant; but with small insects this method of observation is almost impossible. Even if all the different kinds of food eaten could be ascertained in the field, the result would still be unsatisfactory, for the proportions of the various constituents would be unknown, consequently any economic conclusions would be impossible. The examination of the contents of the stomach is the "court of final appeal,"[2] because here the proportions of the different elements of the food can be determined. In researches in economic ornithology, under the direction of Dr. C. Hart Merriam of the U. S. Department of Agriculture, I have examined the stomachs of some 200 catbirds, and found that about half of this bird's food is fruit, while the other half is insects. Beetles and ants form the most conspicuous part of the insect food, and grasshoppers and smooth caterpillars rank next in importance, while spiders, myriapods and bugs are frequently eaten.

Although this method of stomach examination shows conclusively what has been eaten, it neither tells what has been refused nor does it give the preferences of a bird for one kind of food over an other. The reason for this is that the different elements of the food supply where the stomachs were collected is unknown. To obtain such a knowledge of the accessible food supply, and to learn just what insects and berries the birds had an opportunity of eating, I took an excursion on July 30, 1895, to one of the many gullies which intersect the bluff overlooking the estuary of the Potomac, to make observations on the feeding habits of the catbirds, and to collect data and material of the available food supply. The particular gully chosen was about eighty yards wide by twice as long, and extended back at right angles to the river until it rose to the level of the bluff. On the slanting sides of this depression a belt of catbriars (*Smilax*) afforded excellent cover for catbirds. Just above the catbriars and concentric to them was a belt of locust trees. The part of the gully next the river was swampy and supported a forest of willows, while the upper part was drier and afforded an abundance of ripe elder and blackberries upon which birds were seen feeding. The catbirds seemed to devote most of their time to berrying, though some were seen way up in the tops of the locusts, which had been browned as by fire by the locust leaf miners (larvæ of *Odontota dorsalis*), the adult beetles of which were swarming in myriads over the leaves. Several catbirds sang sweetly in the sassafras trees, which were sparingly intermixed with the locusts, while others were seen hopping on the ground where they had a chance to pick up grasshoppers, millers or ants. In all, 15 catbirds were seen in the little gully, and 13 of these were shot. Their entire digestive tracts were examined; 9 of them contained the destructive locust beetle, 18 of these orange and black pests having been taken from one bird. This is surprising, because beetles of this family (*Chrysomellidæ*) secrete a substance which is supposed to be distasteful to birds. Every one of the birds had eaten elderberries, and all but two blackberries. Five of the 13 had taken sassafras berries, and 3 wild cherries. Both of these fruits were bright green and very hard. The eating of such apparently unsavory fruit, when there was a plenty of luscious blackberries seems, to say the least, a whim of aviam epicurianism. In the insect food of these birds there were no ants or grasshoppers, but, on the other hand, the supposedly distasteful locust leaf mining beetles. The countless number of these beetles, and consequently the ease of obtaining them, seems to be the only circumstance to account for the rejection of such favorite food as ants and grasshoppers. Not one of the false caterpillars (*Tenthredinidæ*) that were observed stripping the cornel bushes under the willows was to be found in the catbirds, thus showing that these larvæ are not eaten when the locust beetles are obtainable. From the knowledge gained by the study in this little gully, one would, with a fair degree of accuracy, be able to predict what kind of food catbirds would eat in another gully that had absolutely the same food supply. And so one might perfect this line of research until he could tell just which of the objects a, b, c, d, e, f, g, h in the accessible food supply of a locality a given bird would select.

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[2] Prof. F. E. L. Beal.

Let this suffice for the combination of the field work method with that of the examination of stomach contents. Very often birds that are too shy to be watched in the field may be kept in captivity and then offered various kinds of food. Such experimentation has proved a profitable adjunct to stomach examinations. Among the birds that I have experimented with were four catbirds, which had been recently trapped in the vicinity of Washington, D. C. Among the first insects offered to my birds were a dozen spiny black caterpillars (*Euvanessa antiopa*). The birds, though hungry, refused these repulsive looking creatures. By the next morning the caterpillars that had crawled out of the cage had pupated. I put one of these pupæ on the floor of the cage. It was eyed for some moments by a hungry bird and then devoured. Several days later the pupæ hatched into the brown butterfly which is so common in early spring, and one of these having been given to the birds, they fought over it and each finally obtained part of the insect. Beetles and ants were next tried. In order to prevent them from escaping from the cage, they were put on a piece of cork, which was anchored in a large drinking bowl. The birds soon became accustomed to the cork island with its cargo, and when all the insects had been eaten, often rapped on the cork for more. Bad smelling beetles (*Carabidæ*), which have been supposed to develop their stench to protect them from birds, were snatched as soon as they were put on the cork. Ants, which are highly flavored owing to the large quantity of formic acid which they contain, seemed te be regarded as choice food. Stink bugs (*Pentatomidæ*), whose nauseating odor is familiar to every one who has been berrying, were eaten by the catbirds, even when they had been well fed with other food. Large hard shelled beetles, such as *Passalus cornutus*, were refused by the catbirds, but soft insects, such as grasshoppers, spiders and smooth caterpillars were greedily devoured. Plant lice were not eaten, but the ants which tended them were quickly disposed of.

In making experiments with stinging *Hymenoptera*, I found that my catbirds refused to take honey bees; but a chewink ate one of these insects and died within fifteen minutes. Kingbirds, as a rule, eat only drone bees, but an instance is recorded of a bird that was found with a bee's sting implanted in its tongue. My catbirds regarded slugs (*Gasteropods*) as unsavory, but ate small snails. The birds relished thousand legs and earthworms.

By experiment it was demonstrated that beetle larvæ are regarded as dainty tidbits, but, owing to the fact that they live in such secure places as under sod or in rotten wood, they are seldom found by the catbirds, who has not the bill of the woodpecker to chisel them out, nor the sagacity of the grackle in following the plow.

Having ascertained what insects were eaten by caged catbirds, it will now be instructive to compare the results obtained by experiment with those arrived at by stomach examinations. Beetles formed, in the 200 catbird stomachs examined, the most important part of the animal food, and among these beetles strong scented *Carabidæ* were found oftener than any others. This family is very numerous in individuals, and consequently its members would be the insects which the catbird would most often have an opportunity of picking up. It was first supposed that they were eaten because of the ease of obtaining them and in spite of their offensive smell, until experiment demonstrated that catbirds regard *Carabidæ* as very palatable articles of food. None of the hard shelled beetles, which were refused by captive catbirds, were detected during stomach examinations; on the other hand, such soft animals as spiders and grasshoppers were found in large quantities, thus further showing the coincidence between the results of experiment and stomach examination. Both methods of investigation show that ants are much relished, and that smooth caterpillars are preferred to hairy ones.

Beside experimenting with insects, a series of experiments was conducted with the hope of ascertaining what fruits are preferred by catbirds. Equal volumes of cherries and mulberries were placed on the cork island, and at other times the experiment was repeated with strawberries in place of the cherries, and invariably the mulberries were selected. When there were any hopes of getting mulberries, the birds never touched strawberries or cherries. In the next experiment red and white mulberries were both put into the cage; the birds always took the red ones first. This last experiment showed that catbirds can distinguish colors. The whole series of experiments showed mulberries are preferred to cherries or strawberries, hence it may be inferred that these two latter crops can be protected from catbirds by planting mulberries. This preference for mulberries could not be deduced from stomach examination alone, for the reason that mulberries are not common in many places where catbird stomachs were collected. Experiments with other fruits would have been performed, if my birds had not been killed by a cat.

In recapitulation I would say that in investigating the food of a bird, the first thing to be done is to examine enough stomachs to obtain a general idea of the bird's food. After this has been done, one can intelligently go into the field and watch birds feeding. The different kinds of available food should be noted before collecting stomachs, then it will be possible to ascertain what the bird will eat, its preferences, and what it will refuse.

DR. ALEX. GOETTE ON THE DEVELOPMENT OF THE VERTEBRAL COLUMN.

By O. P. Hay.

In " Zeitschrift für wissenschaftliche Zoologie," Vol. LXII, pp. 343–394, Dr. Alex. Goette has published a paper entitled " Ueber den Wirbelbau bei den Reptilien und einigen anderen